BIOLOGICAL NOTES ON THE SPIDERS OF SOME CITRUS GROVES IN CENTRAL AND SOUTHERN CALIFORNIA[1,2]

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ABSTRACT: This list of the spider species found in several citrus groves in central and southern California is supplemented with biological notes on the more abundant species. Spiders outnumbered all other large predators in the citrus canopy and were also abundant in the litter. *Oxyopes scalaris* (Oxyopidae), *Thiodina* cf. *T. sylvana* (Salticidae), *Misumenops* spp. (Thomisidae) and *Trachelas pacificus* (Clubionidae) were the most abundant vagrant spiders in the canopy. Diet of these spiders is discussed, with emphasis on the spiderlings. Abundant web-building spiders in the canopy were typically small-sized species. These included *Theridion leechi* (Theridiidae), *Erigone dentosa* (Linyphiidae) and *Dictyna reticulata* (Dictynidae). *Hololena* spp. (Agelenidae) were the only abundant web-building large spiders. Sac spiders (Clubionidae) are probably the most promising natural enemies of citrus pest arthropods.

California citrus groves provide a habitat for a variety of spider species, some of which may reduce pest populations, but no general study of them has been published. Collections by researchers at the University of California, Riverside, and the USDA Boyden Entomological Laboratory provided the opportunity to study the spider fauna of citrus groves at varied locations. Field biologies of some species were investigated at the University of California Lindcove Field Station near Exeter, California.

METHODS

Arboreal spiders were taken between 1975 and 1979 by inspection and beating of navel orange foliage in groves at Lindcove Field Station and U.C. Riverside, and in 1973, using a D-VAC® vacuum apparatus, from commercial navel orange groves in Tulare and Fresno counties. Little or no insecticides were applied to the principal groves.

Litter spiders and other arthropod predators were separated by Berlese funnel from samples collected in 1975 from lemon and navel orange groves at U.C. Riverside, and at Orosi in Tulare County. Additional litter collections were taken between 1975 and 1979 from navel orange groves at Lindcove Field Station using pitfalls (Morrill, 1975), direct inspection and Berlese funnels.

[1]Received April 15, 1980

[2]Funds for this research came in part from a National Science Foundation grant No. DEB 75-04223, entitled "Principal Strategies and Tactics of Pest Population Regulation and Control in the Citrus Ecosystem".

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Diets of the principal arboreal species were observed on the trees at Lindcove under natural conditions and in several field experiments. In the latter, first instar spiderlings, hatched in the laboratory, were placed within infestations of citrus thrips [*Scirtothrips citri* (Moulton)], or citrus red mite [*Panonychus citir* (McGregor)], and allowed to run freely while their reaction to the prey was observed. Flashlights aided observations of nocturnal spiders.

RESULTS

In the citrus canopy, spiders outnumbered all other large predators. Sedentary spiders, which snare their prey in webs, and vagrant spiders, which wander about searching for their prey, were represented in approximately equal numbers.

The arboreal vagrant spider fauna was remarkably similar among all of the orchards studied and uniformly included lynx spiders, jumping spiders, crab spiders and sac spiders. Most frequently encountered during the day were the brown lynx spider, *Oxyopes scalaris* Hentz (Oxyopidae) and jumping spiders (Salticidae), particularly *Thiodina* cf. *T. sylvana* (Hentz). Crab spiders (Thomisidae) in the genera *Misumenops* and *Xysticus* were also abundant. Day hunters were replaced at night by sac spiders, *Trachelas pacificus* Chamb. & Ivie (Clubionidae) and related species of Clubionidae and Anyphaenidae.

Brown lynx spiders, *O. scalaris,* usually overwintered as partly grown juveniles and completed maturation in the spring. Between June and September females could be found on brood webs, generally on the outside canopy. Young lynx spiders were abundant by the middle of the summer. Although easily disturbed, these spiderlings were observed eating citrus thrips and a few mites. Hunting lynx spiders sit motionless, usually facing down a twig, for a few minutes, then move to another spot. They rapidly respond to moving prey approaching from any direction, but motionless prey are not attacked. Judging by their small size and hunting strategy, the spiderlings probably eat large numbers of thrips when these are moving about on the twigs in the late afternoon and presumably also numerous small flies and wasps. In the laboratory they will eat leafhopper nymphs and gnats. Larger individuals were observed in the field eating ichneumonid wasps, midges, crane flies and tortricid moths. Cutler et al. (1977) have published a review of the biology of this species.

The jumping spider *Thiodina* cf. *T. sylvana* overwintered in late instar juvenile or mature adult stages. Females were found with egg sacs, usually in rolled leaves in the canopy, from May to September, with early instars most common in June and July. The spiderlings most commonly ate flies and midges, which they perceived at distances greater than 10 cm. and invariably pursued, but they occasionally attacked small wasps, mites and thrips. First instar *Thiodina* spent up to an hour consuming one midge, compared to about five minutes for a mite or a thrips. Thrips were usually

passed unnoticed. Citrus red mites were often rejected; of 17 adult and 17 nymphal mites attacked during the tests, only 2 adults and 8 nymphs were eaten. The spiderlings also rejected scale crawlers, mealybugs and aphids, and fled from ants. The prey did not have to move to be seen if it contrasted strongly enough with the background. Spiderlings attacked apparently motionless thrips, mites, midges, and on two occasions, small pieces of bark. Larger instar *Thiodina* ate various flies, including Syrphidae, Muscidae, Chironomidae and Empididae, and small moths such as Tortricidae. They have been observed in other ecosystems eating lynx spiders (B.T. Carroll, pers. comm.).

In one Lindcove orchard of young navel orange trees, *Thiodina* was uncommon but another jumping spider, *Phidippus johnsoni* (G. & E. Peckham), rarely taken in other orchards, was abundant. *P. johnsoni* probably has a diet similar to that of *Thiodina,* although the spiderlings were more apt to eat mites once captured. In one trial six out of six mites captured were eaten. Larger individuals were observed eating flies and, in one case, a small spider. Gravid *P. johnsoni* were often found overwintering in silken nests in litter or under boards.

Adult crab spiders, *Misumenops lepidus* (Thorell), occupied the canopy in May and June, with the new generation apparent in June. No feeding observations were made on citrus. In other crops such as cotton, *Misumenops* spp. have been reported to eat predominantly flying insects such as flies, wasps, bees, moths and bugs (Muniappan & Chada, 1970; Whitcomb et al., 1963). Another crab spider, *Xysticus californicus* Keys., inhabited both the canopy and the litter. One female in a rolled leaf in the canopy was guarding an egg sac in April.

The abundant sac spider *Trachelas pacificus,* was most prevalent in both the canopy and the litter in the summer and fall, but juveniles and adults were present year around. Since the litter is a population reservoir for this spider, abundance of prey in the litter may influence abundance of spiders in the canopy. These spiders usually spend the day in loose silk nests in rolled leaves or other enclosed spaces. At night they wander rapidly over the canopy, groping for primarily slow-moving or sessile prey such as thrips, mites, insect eggs and lepidopterous larvae. During feeding trials young spiders were very efficient at finding thrips, even under the fruit calyx, but many thrips escaped by flying or dropping off the leaves. Of 43 contacts observed, 19 or slightly less than half were successful captures. This is not abnormally low for predators (Salt, 1967). Spiderlings ate up to six thrips per hour so that each may eat a maximum of 50 thrips per night. Even at this unlikely rate of predation, however, it is doubtful that enough spiders would be present to control a rapidly increasing thrips population. On the other hand, thrips, along with species of innocuous prey, might support a population of sac spiders large enough to control a potential outbreak of lepidopterous or other pests. In the laboratory young *T. pacificus* ate mites,

Trichoplusia eggs (Noctuidae) and agromyzid flies. In one incidence of cannibalism in the field a large individual ate a smaller one.

Chiracanthium inclusum (Hentz) (Clubionidae) and *Aysha incursa* (Chamb.) (Anyphaenidae) occurred in the canopy of some orchards. After extensive laboratory tests of *Aysha* sp. (identified as *A. decepta* Banks but almost certainly *A. incursa*) feeding on citrus thrips, Bravo-Mojica (1975) concluded that this sac spider probably consumed a large number of thrips. Peck (1970) has published a biology of *C. inclusum.*

The danger of sac spider predation may account in part for a curious habit displayed by *Thiodina, Misumenops* and *Oxyopes* (see Cutler et al., 1977). These diurnal vagrant spiders all spend the night hanging on a dragline, in what might be termed "suspended bivouac" by analogy with the similar practice of alpine climbers. The effectiveness of this defence was proven in one instance when a large *T. pacificus* stumbled onto the end of a bivouac line of an *M. lepidus.* The crab spider immediately cut the line and dropped to safety. Not all diurnal vagrant spiders use "suspended bivouac". *P. johnsoni,* for example, spends the night in a heavy silk retreat with multiple entrances.

Among the canopy web-building spiders the most common were small spiders of three families, each of which predominated in a different season. Appearing first were *Theridion leechi* Gertsch & Archer (Theridiidae) and other *Theridion* spp., which were abundant from March to May. They built delicate sheet webs across a single leaf, catching primarily small flies, midges and psocids, but also some thrips, tiny wasps, mites and aphids. Following the Theridiids was a population of *Erigone dentosa* O. P.-Cambridge (Linyphiidae) which appeared in the middle of May and lasted into July. *Erigone* webs were usually spread over several leaves and snared small flies, gnats, psocids, mites and other small insects. The last of the tiny web-builders to appear were the Dictynidae. *Dictyna reticulata* Gertsch & Ivie, abundant in some years from June through August, built irregular webs across one or more leaves. Smiliar webs of *D. calcarata* Banks, found in one year in July, caught numerous small flies and leafhoppers, and many were covered with hundreds of male California red scale *[Aonidiella aurantii* (Mask.)*].*

Thick sheet webs built by *Hololena* n. sp. (Agelenidae), a large funnel-web spider common in many groves, contained various flies, midges, parasitic wasps, small moths, psocids, leafhoppers, bugs, lacewings and spiders. *Hololena* spiderlings, abundant in the spring, built tiny webs across one or more leaves, resembling the webs of the common small web-building spiders. Both adults and spiderlings hide in a tubular retreat and run on the top of the web. At Lindcove, *Hololena* matured in October and later.

Several species of orbweb-weaving spiders were moderately abundant in some groves. *Uloborus diversus* Marx (Uloboridae) built its delicate

horizontal webs usually in the skirts of the canopy or in the fork of the trunk. Some webs caught a few thrips. *Tetragnatha versicolor* Walck. (Tetragnathidae) also built a horizontal orbweb but did not occur in large numbers. Several species of Araneidae, which build vertical orbwebs, inhabited some orchards, and more species will undoubtedly be found. A spring population of *Neoscona oaxacensis* (Keys.) spiderlings occurred in one Riverside orchard. Adults of this large spider appear in the fall (Chirri, 1977). *Cyclosa* sp., a small spider which collected discarded prey, primarily small flies, in a streak across the center of its orbweb, was active at Riverside in the late spring.

Spiders were consistently abundant in citrus litter, but the species composition differed widely from grove to grove. Litter faunas of some orchards were characterized by one or more dominant species, such as *Scotinella* cf. *S. duncani* Chamb. (Clubionidae), *Spirembolus pusillus* Millidge (Linyphiidae) or Oecobius annulipes Lucas (Oecobiidae), that were absent from other orchards. Glatz (1967) stated that the diet of *O. annulipes* was exclusively formicine, but webs of this spider on buildings often contain some flies as well as ants. The litter of most orchards supported a large assemblage of spiders species from a variety of families. Among the vagrants, *Trachelas pacificus* and *Zelotes rusticus* (L. Koch) (Gnaphosidae) were usually abundant beneath the litter surface. In the laboratory *Z. rusticus* ate some psocids, a major litter fauna component. Wolf spiders (Lycosidae) ran on the surface of the litter around standing water. The small *Oardisa ranykisa* (McCook) predominated during the summer, whereas three larger species, *Lycosa gosiuta* Chamb., *Schizocosa mccookii* (Mont.) and *Tarentula kochii* Keys., were more common during the late fall and winter. *Castianeira thalia* Reiskind (Clubionidae) juveniles were active in winter, maturing in the spring. A small jumping spider, *Pellenes formosus* Banks (Salticidae), stalked flies on sunny litter surfaces in the spring, summer and fall. *Sitticus* cf. *S. callidus* Gertsch & Mulaik (Salticidae) was taken in pitfall traps throughout the summer and fall. Web-building spiders of the litter included a large number of small species in the families Linyphiidae and Dictynidae. Most of the Linyphiidae were uncommon or only seasonally abundant, but *Erigone dentosa* was present year around, sometimes at extremely high densities. *Dictyna agressa* Ivie and *D. calcarata* Banks were common, as were the slightly larger spiders of the genus *Tricholathys* (Dictynidae). *Tidarren haemorrhoidale* (Bertkau) (Theridiidae) occasionally built a large web at the base of a tree trunk.

DISCUSSION

Since most species of spiders in the citrus groves feed primarily on

innocuous species of insects, the impact of spiders on citrus pests is probably minimal. The one exception is the sac spiders (Clubionidae and Anyphaenidae) whose prey includes a number of important pest species such as Lepidoptera, mites and thrips. A recent experiment in Israel (David Rosen, pers. comm.) on apple trees demonstrated that when all sac spiders, primarily *Chiracanthium* sp., were removed from the trees the survival of *Spodoptera* sp. (Noctuidae) caterpillars hatching from egg masses on cards was very high, whereas if the spiders were left on the trees very few caterpillars survived. Likewise it is possible that sac spiders are contributing to control of lepidopterous pests in California citrus groves.

The arboreal spider fauna observed in California citrus groves differed notably from that observed by Muma (1975) in Florida. Among the vagrants, only sac spiders were abundant in Florida citrus. Jumping spiders were uncommon and lynx and crab spiders were very rare. The web-building component was more similar to that of California, with Dictynidae, Theridiidae and Uloboridae common, but Linyphiidae were seldom abundant, Agelenidae were absent, and Araneidae were much more abundant than in the California groves. Some of these differences may be due to the biogeography of the spiders involved. For instance, *Erigone dentosa* and the genus *Hololena* both have exclusively western ranges. Other differences between the two faunas may be due to ecological or agronomic factors.

List of Spiders Seen in California Citrus Groves

Family Genus & Species	Records[1]	Habitat
Filistatidae		
Filistata geophila Chamb. & Ivie	Lin.	Litter
Oecobiidae		
Oecobius annulipes Lucas	Riv.	Litter
Uloboridae		
Uloborus diversus Marx	Lin., Fre.	Tree
Dictynidae		
Dictyna agressa Ivie	Lin., Oro. Riv.	Litter
Dictyna calcarata Banks	Lin.	Tree, Litter
Dictyna cf. *D. joaquina* Chamb. & Gertsch	Lin.	Litter
Dictyna reticulata Gertsch & Ivie	Lin., Fre.	Tree
Dictyna saepei Chamb. & Ivie	Lin.	Tree

[1] Lin. = Lindcove, Tulare County; Oro = Orosi, Tulare County; Riv. = Riverside, Riverside County; Fre. = Fresno County.

Tricholathys hirsutipes (Banks)	Lin., Oro.	Litter
Tricholathys jacinto Chamb. & Gertsch	Riv.	Litter
Oonopidae		
Orchestina moaba Chamb. & Ivie	Riv.	Litter
Dysderidae		
Dysdera crocata C. Koch	Riv.	Litter
Pholcidae		
Psilochorus sp. (juv.)	Lin.	Litter
Theridiidae		
Theridion leechi Gertsch & Archer	Lin.	Tree
Theridion melanurum Hahn	Lin.	Tree
Theridion rabuni Chamb. & Ivie	Fre.	Tree
Tidarren haemorrhoidale (Bertkau)	Lin.	Base of Trunk
Linyphiidae		
Erigone autumnalis Emerton	Lin.	Litter
Erigone dentosa O.P.-Cambridge	Lin., Oro., Fre., Riv.,	Tree, Litter
Eperigone eschatologica Crosby	Lin.	Litter
Grammonota gentilis Banks	Lin.	Litter
Spirembolus phylax Chamb. & Ivie	Lin.	Litter
Spirembolus proximus Millidge	Lin., Oro.	Litter
Spirembolus pusillus Millidge	Lin., Oro.	Litter
Spirembolus redondo (Chamb. & Ivie)	Riv.	Litter
Walckenaeria spiralis (Emerton)	Lin.	Litter
Araneidae		
Araniella displicata (Hentz)	Lin.	Tree
Cyclosa sp. (juv.)	Riv.	Tree
Neoscona oaxacensis (Keys)	Lin., Riv.	Tree
Tetragnathidae		
Tetragnatha versicolor Walck.	Lin.	Tree
Agelenidae		
Hololena n. sp.	Lin.	Tree
Hololena sp. (juv.)	Riv.	Tree
Lycosidae		
Lycosa gosiuta Chamb.	Lin., Riv.	Litter
Pardosa ramulosa (McCook)	Lin., Riv.	Litter
Pardosa californica Keys	Lin.	Litter
Schizocosa mccookii (Mont.)	Lin.	Litter
Tarentula kochii Keys.	Lin.	Litter
Oxyopidae		
Oxyopes salticus Hentz	Lin.	Tree
Oxyopes scalaris Hentz	Lin., Fre., Riv.	Tree
Gnaphosidae		
Drassyllus insularis (Banks)	Riv.	Litter
Poecilochroa cf. *P. montana* Emerton	Riv.	Litter
Poecilochroa sp.	Oro.	Litter
Zelotes rusticus (L. Koch)	Riv., Oro., Lin.	Litter

Zelotes n. sp.	Lin.	Litter
Clubionidae		
Agroeca trivittata (Keys)	Lin., Oro., Riv.	Litter
Castianeira cf. *C. crocata* (Hentz)	Lin., Riv., Oro.	Litter
Castianeira thalia Reiskind	Lin., Oro.	Litter
Chiracanthium inclusum (Hentz)	Lin.	Tree
Scotinella cf. *S. duncani* Chamb.	Riv.	Litter
Trachelas deceptus (Banks)	Riv.	Litter
Trachelas pacificus Chamb. & Ivie	Lin., Oro., Riv.	Litter, Tree
Anyphaenidae		
Aysha incursa (Chamb.)	Riv.	Tree
Thomisidae		
Misumenops lepidus (Thorell)	Lin.	Tree
Misumenops sp. (juv.)	Riv., Fre.	Tree
Xysticus californicus Keys.	Lin., Oro., Riv.	Tree, Litter
Philodromidae		
Ebo pepinensis Gertsch	Riv.	Litter
Salticidae		
Metaphidippus vitis (Cock.)	Riv.	Tree
Pellenes formosus Banks	Lin.	Litter
Phidippus johnsoni (G. & E. Peckham)	Lin., Riv.	Tree
Sitticus cf. *S. callidus* Gertsch & Mulaik	Lin., Oro.	Litter
Thiodina cf. *T. sylvana* (Hentz)	Lin., Fre., Riv.	Tree

ACKNOWLEDGEMENTS

My sincerest gratitude to Dr. Norman Platnick and Dr. Willis Gertsch for their aid in identification of difficult specimens and to Dr. Robert F. Luck for his invaluable support and advice.

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